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AUTHOR Selvadurai, Ranjani H.
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ABSTRACT

The purpose of this study was to determine transfer of learning from an introductory to an advanced course in biology. All lecture sections in the advanced course at New York City Technical College were used for random sampling in the study. These lecture sections consisted of a mixture of students who were exposed to techniques of transfer of learning through the introductory course and those who were not exposed to the techniques of transfer of learning, but directly entered the advanced course. The findings of the study indicated that there was a significant difference between the mean cumulative lecture grade of students exposed to transfer of learning and the mean cumulative lecture grade of students not exposed to transfer of learning. As a result of the study it was recommended that the introductory course be mandated as a pre-requisite for the advanced course, and that further studies be conducted for an extended period of time prior to such a decision. It was further recommended that other introductory courses be redesigned and evaluated for positive transfer of learning to advanced courses in the Department of Biological Sciences and college-wide. (Author/TW)

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THE DETERMINATION OF TRANSFER OF LEARNING FROM AN INTRODUCTORY COURSE TO AN ADVANCED COURSE IN THE DEPARTMENT OF BIOLOGICAL SCIENCES AT NEW YORK CITY TECHNICAL COLLEGE

APPLIED EDUCATIONAL RESEARCH AND EVALUATION

by

Ranjani H. Selvadurai, M.S.

New York City Technical College

DR. PHYLLIS COOPER

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Abstract

THE DETERMINATION OF TRANSFER OF LEARNING FROM AN INTRODUCTORY COURSE TO AN ADVANCED COURSE IN THE DEPARTMENT OF BIOLOGICAL SCIENCES AT NEW YORK CITY TECHNICAL COLLEGE

Ranjani H. Selvadurai

The purpose of the study was to determine Transfer of Learning from an introductory to an advanced course in biology. All lecture sections in the advanced course in Fall 1984 were used for random sampling in the study. These lecture sections consisted of a mixture of students who were exposed to techniques of Transfer of Learning through the introductory course and those who were not exposed to the techniques of Transfer of Learning, but directly entered the advanced course.

Statistical analysis was conducted to determine whether there was a significant difference between the mean cumulative lecture grade of students who were exposed to techniques of Transfer of Learning, and the mean cumulative lecture grade of students who were not exposed to techniques of Transfer of Learning. The Null Hypothesis was stated as $H_0 : u_1 = u_2$, and the Alternate Hypothesis was stated as

H_a : $u_1 \neq u_2$. The critical t value for a two-tailed test was established at a significance level of .05. The calculated t value was compared to the critical t value to determine whether or not the Null Hypothesis could be rejected.

The results of the study indicated that the calculated t value was greater than the critical t value at a significance level of .05, thus rejecting the Null Hypothesis. The findings indicated that there was a significant difference between the mean cumulative lecture grade of students exposed to Transfer of Learning and the mean cumulative lecture grade of students not exposed to Transfer of Learning. The results further indicated that the objectives of the redesigned course had been attained.

Implications to the institution as a result of the study were the reinforcement of the importance of periodic assessment of Transfer of Learning from introductory to advanced courses. Positive Transfer of Learning in a hierarchical manner could reduce attrition rate, enhance student enthusiasm and motivation, increase enrollment in more advanced courses. Increased enrollment in subsequent advanced courses will bring added revenue to the college.

As a result of the study it was recommended that the introductory course be mandated as a pre-requisite for the advanced course, and that further studies be conducted

for an extended period of time prior to such a decision. It was further recommended that other introductory courses be redesigned and evaluated for Positive Transfer of Learning to advanced courses in the Department of Biological Sciences and college-wide.

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INTRODUCTION

The introductory course in Principles and Concepts of Chemistry and Biology (BY 100) is a vestibule mandatory course for students who had earned less than a "C" grade in high school chemistry and biology, entering the nursing curriculum at New York City Technical College. This category of students classified as pre-nursing students (pre-N students) enroll in the introductory course (BY 100) in the first semester to alleviate the deficiences in chemistry and biology. Students who had earned a grade of "C" or better in high school chemistry and biology enter the nursing curriculum directly, and are classified as nursing students (N-students). These students register for the mandatory advanced course in Human Anatomy and Physiology (BY 301.1) in the first semester. Both the introductory and the advanced courses are offered by the Department of Biological Sciences as a service department to the nursing curriculum.

In the advanced course (BY 301.1), principles and concepts of chemistry and biology already covered in the introductory course (BY 100) are reviewed. The remainder of the course is devoted to the study of Human Anatomy and

Physiology with an emphasis on application of principles and concepts of chemistry and biology to the physiological processes of the human body.

The Statement of the Problem

During the past years the consensus of the faculty committee of the advanced course (BY 301.1) had been that there was a lack of knowledge in principles and concepts in chemistry and biology transferred from the introductory (BY 100) to the advanced course (BY 301.1). This opened avenues for recommendations resulting in redesigning the introductory course (BY 100) following guidelines in Learning Theories and Principles of Learning to facilitate maximum Transfer of Learning to the advanced course. No evaluation studies had been done by the Department of Biological Sciences to determine the effectiveness of the redesigned course with reference to Transfer of Learning.

Purpose of the Study

The purpose of the study therefore, was to determine whether Transfer of Learning had taken place from the newly redesigned introductory course (BY 100) to the more advanced course (BY 301.1). A Positive Transfer of Learning from the introductory to the advanced course was considered an indication that objectives of the redesigned introductory

course had been achieved. Success rate in the advanced course was used in the project as a paradigm of measurement of Transfer of Learning.

Students with deficiences in high school chemistry and biology enrolled in the introductory course. Students who were exposed to Transfer of Learning through the introductory course and those who were not required to take the introductory course enrolled in the advanced course. The research question in the study was stated as " Is there a significant difference between the mean cumulative lecture grade of students exposed to Transfer of learning and the mean cumulative lecture grade of students not exposed to Transfer of learning? "

Cumulative lecture grades of all sections (12) of the advanced course (BY 301.1) in Fall 1984, were utilized in the study. The students in the twelve sections were categorized into pre-nursing and nursing students with the assistance of the Department of Nursing. The pre-nursing group consisted of students who were exposed to Transfer of Learning through the introductory course in Spring 1984, while the nursing group consisted of students who were not exposed to Transfer of Learning but entered the advanced course in Fall 1984 directly. Thirty students from each group were randomly selected for the study and the cumulative lecture grades from each sample were tabulated. The sample from the pre-

nursing group was designated Group I and that from the nursing group was designated Group II. Appropriate statistical analysis was applied to the data and the calculated t value was compared to the critical t value to determine whether or not the Null Hypothesis was rejected.

The Research Hypothesis

The Research Hypothesis in the project was stated as " There is a significant difference between the mean cumulative lecture grade of students exposed to Transfer of Learning and the mean cumulative lecture grade of students not exposed to Transfer of Learning. "

Background and Significance

The consensus that there was insufficient Transfer of Learning of principles in chemistry and biology from the introductory course to the advanced course led to the redesigning of the former with a thrust for Transfer of Learning. The study was undertaken to determine the achievement of the goals and objectives of the redesigned introductory course through measurement of Transfer of Learning from the introductory to the advanced course. The paradigm for measurement of Transfer of Learning utilized in the study was success rate in the advanced course.

Transfer of Learning is the influence of prior learning on subsequent learning and application. Educational and training programs are constructed with the intent to provide maximum Transfer of Learning. However, educational policies built on the assumption that Transfer of Learning will occur, have come under increasing scrutiny and criticism in the past decade (Ripple et. al., 1982).

Two major prerequisites for Transfer of Learning have been identified. First, something must be learned, and second whatever is learned must be remembered. Transfer of Learning can be Positive or Negative. Positive Transfer occurs when prior learning facilitates subsequent task performances or learning. Negative Transfer occurs when previous learning interferes with, impedes or inhibits later task performances or learning.

Any condition of readiness to learn, motivation, exploration and learner activity or the consequences of the activity that improves learning and retention also increases the possibility of Transfer of Learning (Craig, 1966). Many factors enter into good teaching namely, enthusiasm, knowledge of subject matter, communication skills and one of the most important of them is the deliberate attempt to teach for Transfer. High intelligence has been shown to facilitate Positive Transfer than low intelligence (Bernard, 1965). According to Brigg (1976), although teaching for Transfer

is of prime importance it can be overemphasized to the degree that it actually impedes learning. Negative consequences can occur due to overemphasis that may contribute to a "cold storage" concept of education. "Retroactive Inhibition" is a special case of Negative Transfer. A student may successfully learn subject A and then learn subject B. When such a student attempts to recall subject A, he could draw a complete blank. "Retroactive Inhibition" occurs when the second task works retroactively to inhibit recall of the first task (Sprinthall 1981).

Lateral Transfer refers to the influence of prior learning of a task in the learning of tasks of similar levels of complexity. It may also refer to the use of prior learning in new situations different from the situation in which the original learning took place. In Lateral Transfer the question is how broadly the individual can generalize what he had learned and apply it to a new situation. The most important condition for Lateral Transfer appears to be internal to the individual (Gagne, 1970).

Vertical Transfer refers to the influence of prior learning on the learning of more complex tasks that require higher level skills. The preliminary internal condition for Vertical Transfer is the mastery of subordinate capabilities. Okey and Gagne (1970), examined the effect of learning of subordinate skills in learning of a superordinate skill by

means of a programmed unit. The authors concluded that significantly better performance of the group receiving additional instruction on failed subordinate skills supported the cumulative learning model. Both Lateral and Vertical Transfer of Learning can be Positive or Negative. Earlier learning can render later performances through Specific Transfer (i.e. through usage of skills) or through Non-Specific Transfer (i.e. through usage of principles and concepts).

Research throughout the decades had led to many schools of thought with reference to Transfer of Learning. Early advocates of formal discipline viewed Transfer of Learning to occur as a result of training faculties of the mind. More carefully controlled research led to rest this notion (Judd 1908). Later studies emphasized that mastery of prior tasks did not Transfer to success in the learning of unrelated tasks. Researchers tended to explain the specificity of Transfer of Learning in terms of principles related to their theoretical orientation. According to the identical elements viewpoint, for Transfer to occur identical elements among tasks were required. According to the generalization theory intertask Transfer was accomplished by generalizing principles. Gestalt psychologists argued for Transposition involving the Transfer of broad patterns of relationships among tasks.

Some recent interests have emerged with regard to Non-Specific sources of Transfer. Two Non-Specific sources of Transfer are "Warm up" and "Learning to Learn" (Ripple, 1982). "Warm Up" means improved performance as a result of neutral activity, immediately prior to that performance. "Learning to Learn" means improved performance on subsequent tasks as a function of prior practice on a variety of tasks. "Warm Up" effects are attributed to the activation of "Postural and Orientation Sets" that facilitate performance. "Learning to Learn" effects tend to be more enduring while "Warm Up" effects are transitory and tend to dissipate quickly. The concept of "Learning to Learn" implies the development of strategies or Learning Sets. Preliminary practice on tasks that will Transfer positively to performance in different criterion tasks is required for the development of "Learning to Learn" strategies (Klausmier et. al. 1969).

Learning Sets and instructions are the principle categories of variables essential for explaining and facilitating Transfer of Learning (Gagne, 1962). Learning Sets are inferred from observations of the performance of subjects including their performance on achievement tests. A class of tasks to be learned could be organized into hierarchical structure of Learning Sets. The Learning Sets mediate Transfer of Learning in a unidirectional fashion

from one to another and ultimately to final performance (Gagne et. al, 1962). According to this view the acquisition of knowledge of increasingly higher complexity was markedly facilitated by the acquisition of relevent prior Learning Sets or capabilities. Conceptual understanding and performance occur at each higher level when previously acquired understanding plus new material undergo cognitive restructuring. The higher level produced is qualitatively different from the behavior designated by the tasks of the lower level. All of the subordinate sets comprise the necessary elements for problem solution (Eustace, 1969).

Non-Specific Transfer phenomena as a result of "Warm Up" and "Learning to Learn" have been demonstrated in both verbal and motor skills (Hogan, 1978). When the same method of practice and the same class of materials are employed in initial and subsequent tasks, "Learning to Learn" is maximal. Also, "Learning to Learn" increases as a function of practice, but the rate of learning is a function of the particular paradigm employed (Postman et. al., 1964). Research by Wollman (1984), indicated that minimal instruction enabled most students to acquire not only effective concepts for organizing and transferring knowledge in a problem domain, but also a first introduction to the higher order concepts of organization and Transfer.

Several general applications can be drawn from research on Transfer of Learning. Studies indicated, for Transfer to be effective, assessment of the characteristics of students performing a particular task was necessary. The objectives of a particular course of study should also be clearly defined. The designing of the subject content and instruction should be in a hierarchical manner (Gagne, 1962). This is believed to promote Transfer of Learning within the course and to subsequent courses. The subject matter should be organized in a continiuum from specificity to generality. Mental abilities and skills could be encouraged to promote Transfer of learning from simple to complex through comprehension. application, analysis, synthesis and evaluation (Bloom, 1956).

In contrast to hierarchies based on a logical task analysis procedure, a number of studies have derived hierarchies founded on Piagetian ideas of cognitive development. While learning hierarchies derived by task analysis focus upon the characteristics of skilled performance of the task and its prerequisites, developmental hierarchies are likely to be concerned with unskilled as well as skilled performances as these appear in the natural setting. According to Resnick (1973), "Hierarchies generated in this way will tend to treat errors and misunderstandings typical of earlier stages as necessary prerequisites for the

individual to reach higher stages." In the developmental model the resolution of these difficulties by the learner himself is necessary in the development of his intellectual structures. In this way equilibration occurs. Attempts to smoothly induce Specific Vertical Transfer through a learning hierarchy may therefore be antithetical to the developmental hierarchy model. Developmental hierarchies are usually validated by psychometric methods rather than by the determination of significant Positive Transfer. In essence, the learning hierarchy is prescriptive, whereas the developmental hierarchy is descriptive (Griffiths et. al., 1983).

Generalization of principles and concepts is believed to facilitate recall and retrieval. Transfer of Learning has been found to be enhanced by mediators such as verbalizing or through demonstrations. Research on Transfer of Learning also bring to focus the importance of variety of experience by practice on different problems related to the topic by verbal communication and group discussions. Group discussions have been shown to promote maximum Positive Transfer of Learning (Gagne, 1962).

With reference to evaluation of courses and students to assess Transfer of Learning, some suggestions have been recommended through research findings. Courses should be re-examined periodically to assess if Positive Transfer could

be made to subsequent courses. Assessment of Transfer of Learning could be done by usage of different paradigms. The basic research paradigms identified by Stephens (1960), and Klausmeier and Davis (1969), have been used by researchers investigating Transfer phenomena. In brief, procedures involved two groups of subjects, a "Transfer" and a control group. In the "Standard Transfer Design" the "Transfer" group learned task 1 and after an interval of time learned task 2. The control group learned only task 2. It was inferred that difference between the groups in learning task 2 represent Transfer effects. Many variations from the "Standard Transfer Design" have been used by experimenters depending on the nature of the research question.

Outcomes of learning are persistent states that enable an array of human performances. Five varieties of learning outcomes namely, intellectual skills (procedural knowledge), verbal information (declarative knowledge), cognitive strategies (executive control processes) motor skills and attitudes have been distinguished. It is believed that results indicating the effects on learning of most principal independent variables can be generalized within these categories and not between them (Gagne, 1984).

During the past decade had evolved a trend away from theoretical claims that attempt to account for Transfer of Learning. With some notable exceptions, most

investigators have ceased to look or hope for global theories of Transfer of Learning (Ripple et. al., 1982).

The project was appropriate for the seminar on Applied Educational Research and Evaluation, as measurement of Transfer of Learning using the paradigm of success rate of the control and experimental groups in the study involved statistical concepts and application. Experimental design, methods of statistical analysis and application formed an integral component of the seminar.

PROCEDURES

In an effort to determine Transfer of Learning from the introductory course in Principles of Chemistry and Biology (BY 100) to the more advanced course in Human Anatomy and Physiology (BY 301.1), the following procedures were implemented.

Procedures for Collecting Data

Permission to conduct the study was obtained from the chairperson and course committees of BY 100 and BY 301.1 of the Department of Biological Sciences. Further review of literature of Transfer of Learning was accomplished with the assistance of an Eric Search and the Libraries of the City of New York.

Cumulative lecture grades of all twelve sections of the advanced course (BY 301.1) in Fall 1984 were obtained from the Department of Biological Sciences. The students in the twelve sections were categorized into pre-nursing and nursing students in consultation with the Department of Nursing. The pre-nursing group consisted of students who were exposed to techniques of Transfer of Learning in BY 100. The nursing group consisted of students who were not exposed to techniques of Transfer of learning through BY 100. Cumulative lecture grade from the twelve sections of BY 301.1 for pre-nursing and nursing groups were tabulated separately. A sample size of thirty from each group was selected at random for the study. The sample from the pre-nursing group was designated Group I and the sample from the nursing group was designated Group II.

Procedures for Treatment of Data

The Mean and Standard Deviations of cumulative lecture grades of Group I and Group II were computed. The Null Hypothesis (H_0) was stated as H_0: $u_1 = u_2$ (u_1 = mean cumulative lecture grade of Group I; u_2 = mean cumulative lecture grade of Group II). The Alternate Hypothesis was stated as H_a: $u_1 \neq u_2$. The level of significance was established at .05. The degrees of freedom were calculated for Group I and Group II, and the critical t value for a

two-tailed independent t test was established. The t value was calculated using the appropriate formula. The calculated t value was compared to the critical t value to determine whether or not the Null Hypothesis was to be rejected.

The results of the study were presented to the chairperson and relevant course committees of BY 100 and BY 301.1 of the Department of Biological Sciences with recommendations for additional studies to ascertain further validity of the project.

Limitations of the Study

The study was limited to students in the nursing curriculum. In addition the project was limited to the sections of BY 301.1 in Fall Semester of 1984. Another limitation of the project was the restriction only to lecture sections of the advanced course. In the study only generalization of principles of Transfer of Learning were estimated.

Basic Assumptions

An assumption of the study was that both groups of students had been exposed to the same subject matter in chemistry and biology before entering the advanced course (BY 301.1). Further, it was assumed that the two groups were homogeneous with respect to age, sex, reading and

comprehension levels, intelligence and motivation. Students who entered the advanced course (BY 301.1) directly were assumed to have had no exposure to techniques of Transfer of Learning of principles and concepts of chemistry and biology in high school. It was further assumed that reasonable representations of both groups of students were in the sections of the advanced course (BY 301.1) involved in the study.

Definition of Terms

The operational definition of terms in the project were as follows:

BY 100	Course code for the introductory course in Principles of Chemistry and Biology.
BY 301.1	Course code for the advanced course in Human Anatomy and Physiology.
Pre-nursing student (Pre-N student)	Student who entered the nursing curriculum with less than a "C" grade in high school chemistry and biology.
Nursing student (N-student)	Student who entered the nursing curriculum with a "C" or higher grade in high school chemistry and biology. This student did not take the introductory course but registered directly for the advanced course in the first semester.
Cumulative lecture grade	Average of four class examinations and one comprehensive final examination.

RESULTS

Table 1 represents the Mean and the Standard Deviations of Group I (Experimental Group) and those of Group II (Control Group).(See appendices A, B and C for calculations of Means, Standard Deviations and t Value).

Table 1

Mean and Standard Deviations of Group I and Group II For a Sample Size of Thirty

Group I	Group II
$\bar{X}$ = 75.00	$\bar{X}$ = 71.27
S.D.= 10.55	S.D.= 9.7
Sample Size = 30	Sample Size = 30

Level of Significance : .05

Degrees of Freedom : 58

Critical t Value : t $\pm$ 1.96

Calculated t Value : 7.79

The Mean for Group I (Experimental Group) consisting of students exposed to Transfer of Learning was 75.00 with a

Standard Deviation of 10.58 for a sample size of 30. The mean for Group II (Control Group) of students who were not exposed to Transfer of Learning was 71.27 with a Standard Deviation of 11.03 for a sample size of 30. The critical t value for 58 degrees of freedom at a significant level of .05 was established at ± 1.96. The calculated t value for an independent t test was 7.79.

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The results of the study indicated that the calculated t value was greater than the critical t value at a significance level of .05. Therefore, the Null Hypothesis was rejected indicating that there was a significant difference between the mean cumulative lecture grade of students exposed to Transfer of Learning and the mean cumulative lecture grade of students not exposed to Transfer of Learning. The findings confirmed that the mean cumulative lecture grade of 75 for Group I (Experimental Group) compared to the mean cumulative lecture grade 71.27 for Group II (Control Group) was significantly different indicating a Positive Transfer of Learning from the introductory to the advanced course. The results of the study further indicated that the objectives of the redesigned introductory course had been attained thus, facilitating Transfer of Learning of principles and concepts of chemistry and biology from the former to the more

advanced course. Redesigning the introductory course seemed a worthwhile endeavor in facilitating the learning process.

Both Lateral and Vertical Transfer of Learning were demonstrated in the study. Lateral Transfer of Learning refers to the influence of prior learning of a task in the learning of tasks of similar levels of complexity (Gagne 1970). Vertical Transfer of Learning refers to the influence of prior learning in the learning of more complex tasks that require higher level skills (Okey and Gagne 1970). The principles of chemistry and biology learned in the introductory course (BY 100) with a specific thrust for Transfer of Learning was reviewed in the advanced course thus indicating a Lateral Transfer of Learning. The study demonstrated Vertical Transfer of Learning by the influence of prior learning in the introductory course (BY 100) of concepts and generalizations of principles of chemistry and biology in mastering of more complex physiological processes of the human body learned in the advanced course (BY 301.1).

The introductory course was redesigned with an intent for maximum Transfer of Learning. Pre-nursing students enrolled for the introductory course in Spring 1984. Students mandated to take the introductory course and those who were exempted from the introductory course enrolled for the advanced course in Fall 1984. The interval of neutral activity during the Summer months of 1984 provided a period

of "Warm Up" for facilitating Transfer of Learning to the more advanced course. A non-specific source of Transfer of Learning is "Warm Up". This phenomenon means improved performance as a result of neutral activity immediately prior to a learning task (Klausmeier et. al. 1969).

Literature cited recommendations for evaluation of courses periodically to assess if Positive Transfer of Learning could be made to subsequent courses. Assessment of Transfer of Learning could be done by the usage of different paradigms. The basic research paradigm of success rate identified by Stephen (1960) and Klausmeier and Davis (1969) was utilized in the project.

The study had some implications for the institution. Reexamination of introductory courses periodically to assess Transfer of Learning to advanced courses seemed feasible for good teaching and learning outcomes. Further, where Positive Transfer of Learning takes place in such a hierarchical sequence, the attrition rate in the advanced course could be reduced. A good learning outcome in the advanced course will facilitate student enthusiasm, motivation and will speed up the graduation process. Retention of the students in the advanced course will further increase the enrollment in the more advanced courses in the following semester which in turn will increase the revenue to the college.

As a result of the study the following recommendations were made to the Department of Biological Sciences and to the administration of New York City Technical College:

1. Mandating the introductory course (BY 100) as a pre-requisite for the more advanced course BY 301.1 for students in the nursing curriculum.

2. Further studies be conducted for an extended period before mandating the introductory course as a pre-requisite for the advanced course.

3. Redesigning of other introductory courses with similar evaluations in the Department of Biological Sciences to ascertain Transfer of Learning to advanced courses.

4. Reexamination and evaluation of introductory courses in other curricula at the college for determination and facilitation of Transfer of Learning.

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APPENDIX A

Calculation of the Mean and Standard Deviation for Group I

Student No.	X_1	X_1^2
1	79	6241
2	62	3844
3	70	4900
4	85	7225
5	68	4624
6	89	7921
7	75	5625
8	45	2025
9	80	6400
10	68	4624
11	72	5184
12	75	5625
13	78	6084
14	85	7225
15	88	7744
16	62	3844
17	80	6400
18	90	8100
19	80	6400
20	79	6241
21	69	4761
22	75	5625
23	77	5929
24	75	5625
25	56	3136
26	60	3600
27	77	5929
28	72	5284
29	90	8100
30	89	7921
n = 30	$\Sigma X_1 = 2250$	$\Sigma X_1^2 = 172086$

$\bar{X}_1 = 75$

$$\sigma = \sqrt{\frac{n(\Sigma X_1^2) - (\Sigma X_1)^2}{n^2}} = \sqrt{\frac{30\,(172086) - (2250)^2}{30 \times 30}}$$

$= 10.55.$

APPENDIX B

Calculation of the Mean and Standard Deviation for Group II

Student No.	X_2	X_2^2
1	68	4624
2	78	6084
3	80	6400
4	60	3600
5	70	4900
6	70	4900
7	50	2500
8	65	4225
9	75	5625
10	70	4900
11	70	4900
12	68	4624
13	72	5184
14	82	6724
15	87	7569
16	72	5184
17	89	7921
18	75	5625
19	73	5329
20	76	5776
21	80	6400
22	55	3025
23	58	3364
24	60	3600
25	78	6084
26	82	6724
27	70	4900
28	80	6400
29	75	5625
30	50	2500
$n = 30$	$\Sigma X_2 = 2138$	$\Sigma X_2^2 = 155216$

$\bar{X}_2 = 71.27$

$$\sigma = \sqrt{\frac{n(\Sigma X_2^2) - (\Sigma X_2)^2}{n^2}}$$

$$= \sqrt{\frac{30\,(155216) - (2138)^2}{30 \times 30}}$$

$$= 9.7$$

APPENDIX C

Calculation of the t Value

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1^2} + \frac{s_2^2}{n_2^2}}}$$

$$t = \frac{75.00 - 71.27}{\sqrt{\frac{10.55^2}{30^2} + \frac{9.7^2}{30^2}}}$$

$$t = \frac{3.73}{\sqrt{\frac{111.30}{900} + \frac{94.10}{900}}}$$

$$t = \frac{3.73}{\sqrt{.124 + .105}}$$

$$t = \frac{3.73}{\sqrt{.229}} = \frac{3.73}{.479}$$

$$t = 7.79$$